

# **The Coastal Ocean Processes (CoOP) Program**

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## **LONG-TERM GOAL**

Coastal Ocean Processes (CoOP) is a program that seeks to plan and implement multi-investigator, interdisciplinary research in the coastal ocean. CoOP encompasses the disciplines of Biological, Chemical, Geological and Physical Oceanography, plus Marine Meteorology. The goal of CoOP is to obtain a new level of quantitative understanding of the processes that dominate the transports, transformations and fates of biologically, chemically and geologically important matter on continental margins.

## **SCIENTIFIC OBJECTIVES**

CoOP's underlying scientific planning assumption is that a series of well designed, interdisciplinary processes studies will provide significant new information to advance our understanding of coastal oceans that will have applicability to the continental margins around the world. Coupled process studies and modeling are the core of CoOP research programs.

## **APPROACH**

The CoOP research plan is to conduct process and modeling studies on shelves which differ in the dominant physical processes which influence cross margin transport. CoOP studies will thus attempt to isolate the key processes that have some global generality and to study these in detail on margins where effects can be isolated with a maximum degree of confidence. Modeling studies will be integrated with the process studies and used as a means to synthesize and generalize study results. Five shelf types that CoOP will study are:

*Wind-driven Transport* - The defining characteristic of this shelf type is that current fluctuations are predominantly driven by winds (either locally or remote) on time scales longer than a day. A subset of these shelves are those where seasonal upwelling occurs, such as off the California and Oregon coasts as well as shelves of Portugal, Southwest Africa and western South America. The broader category of wind-driven transport would include all of the U.S. continental shelves.

*Tidally-driven Transport* - In areas such as Georges Bank and the Bering Sea, strong tides can determine mixing processes and mean flows. High tidal amplitudes are generally the result of a wave resonance in a "cavity", so that tidally dominated regions tend to be in or near areas with complex

coastlines.

*Buoyancy-driven Transport* - Fresh water discharge from rivers creates an alongshore flow. In areas where the freshwater discharge is relatively low (Middle Atlantic Bight) buoyancy- driven transport is limited to the inner shelf. However, in areas of heavy precipitation such as the south coast of Alaska and off Norway, buoyancy-driven flows can dominate the entire shelf.

*Western Boundary Current (WBC) shelves* - Cross margin transport on these shelves can be influenced by strong ocean offshore currents such as the Gulf Stream and Kuroshio as well as eddies that originate from strong boundary currents. This category would thus include all of the Atlantic seaboard as well as the Gulf of Mexico (due to the Loop Current).

*Ice-covered Shelves* - In the Great Lakes and Northern Alaska there are seasonally ice-covered shelves. Ice formation and brine rejection can result in the formation of deep or intermediate water mass formation which can contribute to cross-shelf transport. Once ice is formed, it can strongly mitigate exchanges of heat and momentum between the ocean and atmosphere.

## WORK COMPLETED

*Inner Shelf Dynamics* - The first CoOP study was initiated off Duck, NC in 1992 in response to a call for proposals to study transport on inner shelves. A collaborative research initiative was developed through funding from the Office of Naval Research (ONR), the National Science Foundation (NSF) and the Army Corps of Engineers. This region has not been widely studied because the strong wave activity on the inner shelf makes it difficult to maintain moorings and to operate ships. The interdisciplinary

CoOP project focused on the suspension and cross-shelf transport of sediments and the planktonic larvae of inner shelf benthic invertebrates. The investigators used both a cross-shelf array and ship surveys to study the physics, sediments and plankton of the inner shelf. Conditions of both upwelling and downwelling favorable winds during the study period resulted in different water property characteristics (Figure 1) as well as larval concentrations. The patterns of larval abundance are a consequence of habitat affinities of the different taxa as well as wind-driven cross-shelf transport.

*Coastal Air-Sea Chemical Fluxes* - In order to develop a quantitative, mechanistic understanding of how gases are transported between the coastal atmosphere and ocean, CoOP initiated a program to improve our ability to estimate chemical fluxes in coastal regions. In 1995 a cooperative program was

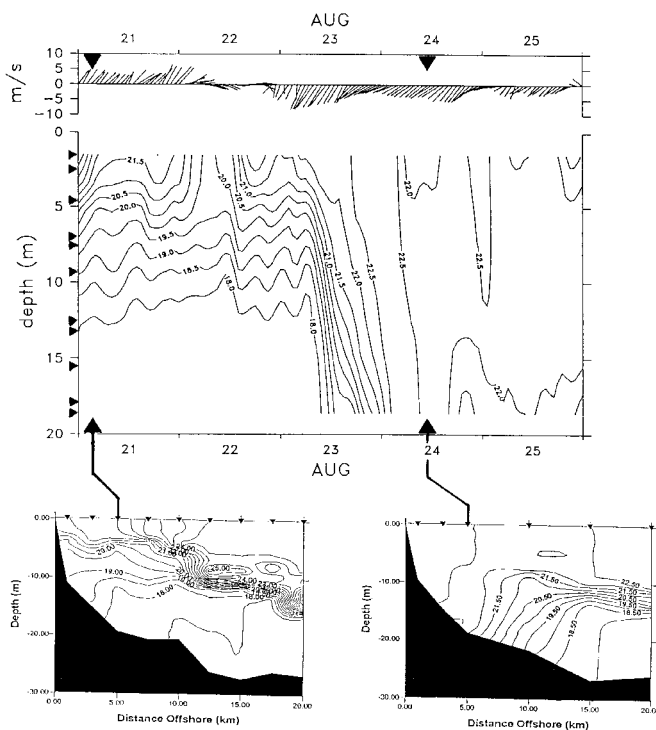
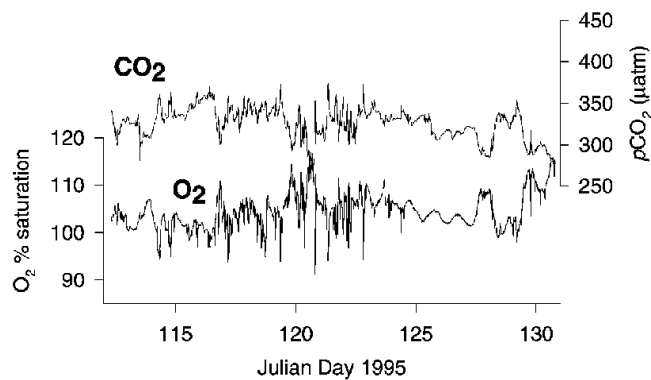


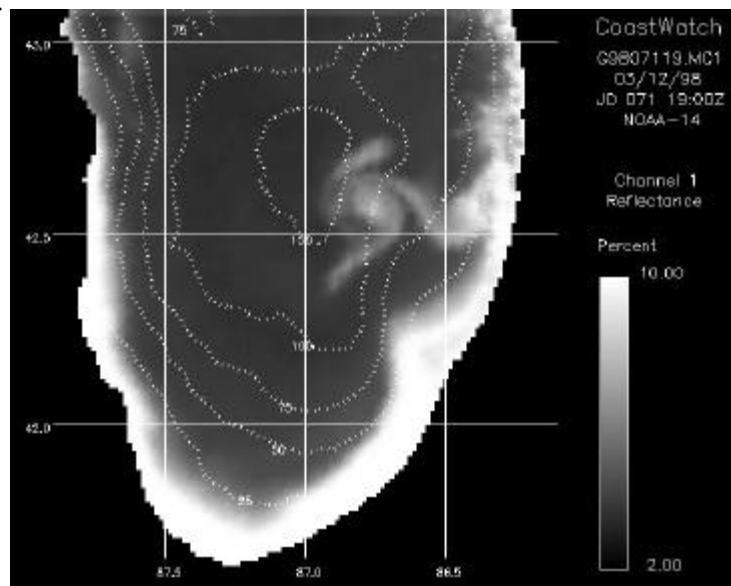
Figure 1.



**Figure 2.**

developed between CoOP and ONR sponsored Marine Boundary Layer Research Initiative and the Minerals Management Service (MMS). CoOP investigators focused on air-sea gas exchange; MMS studied surface flux and Langmuir circulation dynamics; and, ONR's research effort focused on exchange of momentum, heat aerosols, and the dynamics of the atmosphere and oceanic boundary layers. CoOP investigators developed both new both underway mapping systems and moored *in situ* sensors to measure gases (Figure 2).

*Great Lakes Processes Studies* - In 1997 CoOP in collaboration with the NOAA Coastal Ocean Program began interdisciplinary process studies on cross-margin transport in the Great Lakes. The study of Episodic Events: Great Lakes Experiment (EEGLE) will focus on the role of the annually recurrent southern Lake Michigan plume in transporting material across the margins of Lake Michigan (Figure 3). Mooring arrays, ship surveys, drifter studies and radar sites will be used to track the plume, surface currents and the particle field. Another CoOP Great Lakes project is The Keweenaw Interdisciplinary Transport Experiment in Superior (KITES). The Keweenaw Current forms a semi-permeable barrier along the coast that inhibits shore and river derived material from crossing the central basin of Lake Superior. Water movement in this current is the primary means for transport of material from the western to eastern lake basin and is therefore likely to be important in dictating productivity throughout the whole lake.



**Figure 3.**

## WORK PLANS

*Wind-driven Transport Study* - In 1998 CoOP solicited proposals for an interdisciplinary process study of wind-driven transport in the NE Pacific. The central focus of this planned study is to determine the processes that control the cross-margin (inshore to offshore) transport of biological, chemical and geological materials in a strongly wind-driven system. CoOP is currently funding a modeling study by John Allen (Oregon State University) to investigate the effects of three-dimensional wind-forced circulation processes on ecosystem dynamics under both upwelling and downwelling conditions. Two interdisciplinary CoOP process studies will begin this year. Coastal Ocean Advances in Shelf Transport

will examine wind-driven transport processes off the Oregon coast. Another study will focus on the role of wind-driven transport in controlling shelf productivity off the N. California coast.

*Buoyancy-Driven Transport* - In the fall of 1998 CoOP conducted an open workshop to develop a Science Plan for a buoyancy-driven transport study. The final workshop report will be released in the fall of 1999. This next year CoOP will develop a Buoyancy-Driven Flux Science Plan. In addition, with support from ONR, CoOP will solicit review papers which synthesize important interdisciplinary issues in buoyancy-driven transport.

## **CoOP INFORMATION**

Copies of the CoOP reports and NEWSLETTER can be obtained through the CoOP office (hawkey@hpl.umces.edu). A description of the CoOP program and the various process and modeling studies can be found at the CoOP web site (<http://www.hpl.umces.edu/coop>).